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Agricultural Memorandum No. 1030

The Significance and Variability of Relative Humidity in Hop Downy Mildew Control

by I A Barrie

Summary

A long established operational scheme for predicting the disease risk from hop downy mildew uses 48 hour totals of rainfall and hours with relative humidity greater than 90%. The accuracy of RH measurements are discussed and the daily chart records of RH from four sites in South Shropshire and Herefordshire during 1983 are used to show that any geographical variations in RH cannot be assessed with sufficient accuracy to significantly alter the calculated index of hop downy mildew risk.

Introduction

Following studies of the incidence of Hop Downy Mildew (HDM) over several years at Wye College empirical relationships were derived to link recorded values of rainfall, leaf wetness and high RH to HDM infection periods. The best of the relationships included additional information on spore counts vis a vis.

$$I = 23 (H) + 66 (R) + 2 S + 37 \quad \text{(Royle 1979)}$$

where I is the infection index

H = hours of leaf wetness) total over previous

R = rainfall total (mm)) 48 hours

S = spore count)

Given the practical difficulties in measuring hours of leaf wetness and spore counts, an equation using weather criteria alone is more easily applied.

$$I = 22 (RH) + 84 (R) - 63$$

RH = the total of hours with RH $\geq$90% during the past 48 hours

Two corrections are applied to the index:

1. if the 48 hr rainfall total is zero then I = 0
2. if the average temperature during the wet period is less than 8°C, then I = 0.

An index of 500 or above indicates an infection period.
Each of the 4 co-operating growers record RH with a hair hygrograph, exposed in white, louvred screens situated close to their homes, rather than in the hop yards. The information is telephoned twice weekly to an ADAS office where the regression equation is evaluated (Annex A).

Similarly, the growers assess their own recordings to assist in the optimum timing of disease control measures.

Although there may be practical advantages using RH measurements rather than leaf wetness the accuracy of the measurements with respect to the natural spatial variability needs to be assessed.

Measuring RH

Currently a hair hygrograph is on loan to each of 4 growers. The instruments are carefully calibrated prior to the onset of each season. During calibration the error in recording RH records above 90% is typically ± 1 hour per day.
During transport to the growers a shift in calibration is to be expected.
Follow up checks were not performed during 1983 and the effect of a shifting calibration is evident from the season's results when the maximum RH commonly recorded varied between sites. This error has produced a bias in the results: see table 1

Table 1
Maximum RH Levels Recorded and Seasonal Totals for RH >90% 1983
Note: the common maximum should be very close to 100%.

	Common Max	Total Hrs >90% (May-Aug)
Ledbury	97-99%	1135
Leominster	92-95%	984*
Tenbury	94-95%	1201
Leigh Sinton	99-100%	1224

* Contains some estimated values during July and August.

Geographical Variation of RH

Any changes in RH primarily reflect changing temperatures as the atmospheric moisture content will alter only slowly, thus variation between sites will be influenced by

1. Variations in temperature due to frost hollows, aspect etc
2. Subsequent effects ie fog
3. Local sources of moisture from ground or surface water and vegetation.

To accurately record RH variations due to the above factors requires an inter-hygrograph consistency of not worse than $\pm$ 1 hour. The influence of the recorder accuracy is evident from table 1 where the rankings show that the recorders with the highest max's also tended to record the greatest total of hours.

Figure 1 illustrates the kind of gross inconsistencies that occur between hygrographs. The differences in recorded totals at Tenbury and Leominster can be wholly attributed to the erroneously low readings at Leominster, especially during the 21/22nd and 23/24th June.

Analysis of the daily totals of RH hours >90% show that recorded site to site variations exceeding 3 hours are never the less scarce; between May and August only 16 such days were noted. The daily mean of the number of hours per day when RH was >90%, the range between the highest and lowest recorded totals, and the standard deviation of these ranges were calculated each month: see table 2.

Table 2

Daily Means of RH >90% Periods and Inter-Site Ranges

	Daily Mean* (hrs)	Mean Daily+ Range	S D of Range
May	11.4	2.2	1.1
June	7.7	2.1	1.4
July	9.3	2.0	1.2
Aug	9.2	1.8	1.0

* average of all 4 sites

\+ highest 24 hr site total less the lowest

If only the days during which rainfall was recorded are examined for periods of high RH, the daily mean total of hours is found to be around 40% higher than the values in table 2.

Conclusions and Discussion

Following calibration and delivery in 1983 the grower's hygrographs were not regularly checked. The resulting accuracy to which periods of high RH were recorded was insufficient to evaluate inter-site variations. However, the overwhelming effect of the diurnal variation in temperature on RH produced a mean daily range between the highest and lowest daily site totals of around two hours while the daily mean total of hours with RH >90% was 8-11 hours. During days with rain the mean daily total of hours with RH >90% was around 40% higher than the overall mean.

During 1984 a closer check is being maintained on the performance of the recorders, but the additional accuracy is expected to be small, and still be of a similar order to the means of the daily ranges recorded during 1983. Thus it will still be impossible to determine any systematic differences between sites due to microclimatic effects. The gross errors evident on a few days during 1983 should be eliminated in 1984, however.

Despite being easy to interpret, hair hygrographs are not at all well suited to this particular application. A reduction in the number of hygrographs to perhaps only two, combined with careful supervision, is justified.

If recordings at several farms are to be taken then new instrumentation which allow more definitive and pertinent monitoring should be considered.

Further Work

1. This exercise will be repeated for the 1984 season to confirm or refute the above conclusions.
2. A leaf wetness sensor and thermistor linked to a chart recorder have been placed in the Rosemaund EHF hop yard to assess the advantages of this system over the conventional one.
3. A Crop Disease Environment Monitor (CDEM) is currently undergoing field trials at Rosemaund EHF. Indices of HDM infection periods are being calculated daily.

References Royle D J 1979 Wye College Annual Report 1978

Any comments of suggestions should be referred to the author.

Met Unit
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Wolverhampton
29 August 1984

Acknowledgement

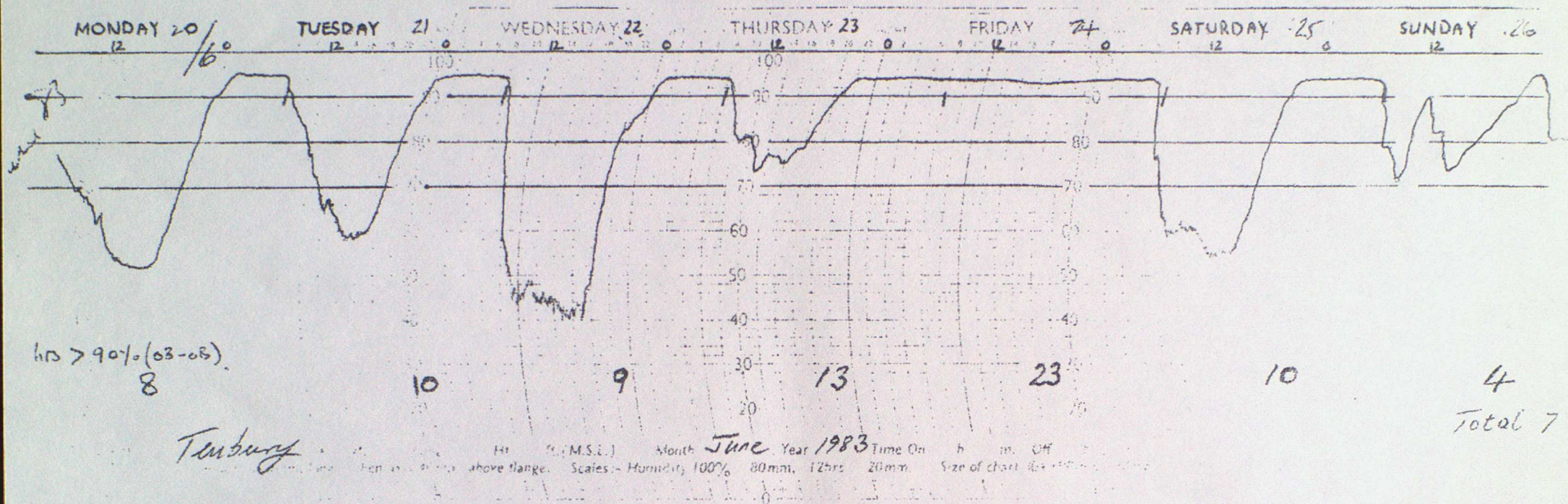
The co-operation of the hop growers, Mr D Wareham, Mr H Nott, Mr N Young and Mr Burgess, and the staff at Rosemaund Experimental Husbandry Farm who all made their carefully tabulated recordings available for analysis, is greatly appreciated. The Met Unit clerk, Bob Taylor, assisted with much of the preparation of the data.

SITE: MONTH: YEAR: ANNEX A

Predicted degree of Downy Mildew Attack: (84 x mm of rain + 22 x no. of hrs with RH 90% - 63)

Date	Rainfall (mm)	A	Relative humidity hrs over 90%	B	A + B	48 hr total
		Rainfall in mm x 84		Relative humidity over 90% x 22	Predicted Infection	ie current Day + previous Day - 63
1	0	0	10	220	220	0
2	0	0	5	110	110	0
3	5	420	10	220	640	687
4	1	84	6	132	216	793
5	0	0	8	176	176	392
6	0	0	12	264	264	0
7	0	0	15	330	330	0
8	0	0	4	88	88	0
9	0	0	10	220	220	0
10	10	840	15	330	1170	1327
11	0	0	0	0	0	1107
12	2	168	12	264	432	369
13	0	0	10	220	220	589
14	0	0	5	110	110	0
15	0	0	8	176	176	0
16						
17						
18						
19						
20						
21						
22						
23						
24						
25 etc						

NOTE: A + B column should not be zero if B greater than zero.



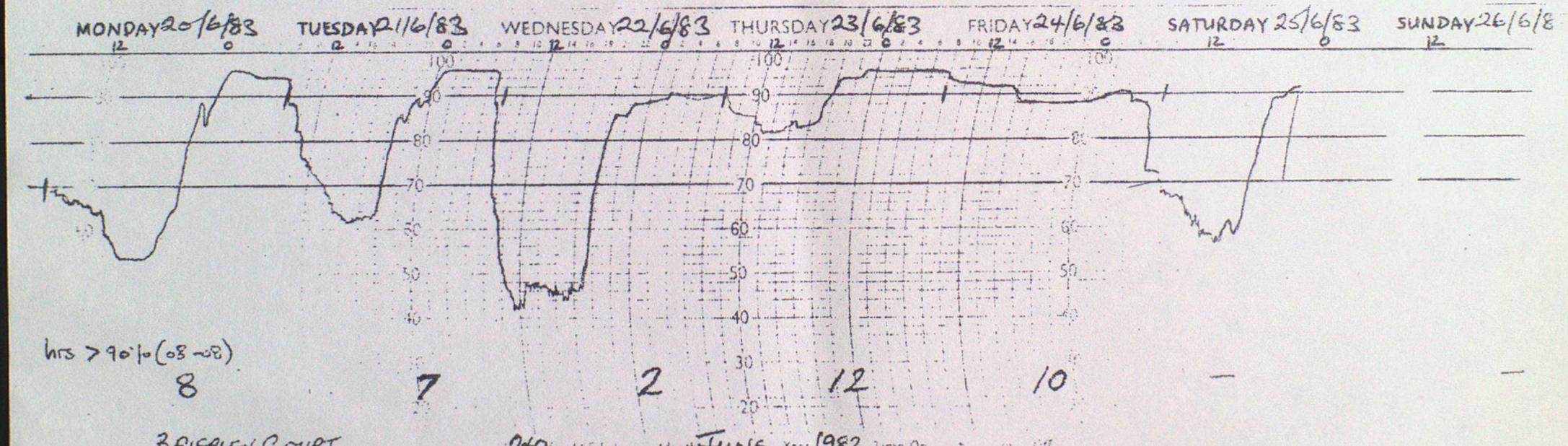
hrs > 90% (03-08)

8 10 9 13 23 10 4

Total 7

Tenbury ... (M.S.L.) Month June Year 1983 Time On ... h ... m. Off ...

... above flange. Scales:- Humidity 100% 80mm. 12hrs 20mm. Size of chart ...



hrs > 90% (03-08)

8 7 2 12 10 — —

BRIERLEY COURT (LEOMINSTER) ... (M.S.L.) Month JUNE Year 1983 Time On ... m. Off ...

... Scales:- Humidity 100% 80mm. ... 20mm. ...